Biomedical Applications of Biodegradable Polyesters

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ABSTRACT

In recent years, the emphasis in the field of biomedical engineering has shifted to biodegradable polymers, and particularly polyesters. There are hundreds of polyester-based medical devices on sale, and more are added to the market every year. The mechanical efficiency and wide range of biodegradation properties of this polymer class allow for high degrees of target selectivity for clinical applications. Recent research efforts to extend the application of polymers were motivated by a need to address polyesters' general hydrophobic nature and their restricted cell motif sites. This study offers a thorough investigation into innovative techniques for manipulating polyesters for possible biomedical applications and their therapeutic potential. The global demand for regenerative implantation surgery, therapeutic cell cultivation and tissue reconstruction is around US$ 23 billion, and by the end of 2025 it is expected to hit US$ 94.2 billion Synthetic biodegradable polyesters are known as the most commercially viable polymers for these applications because they can be replicated cost-effectively with a large range of characteristics. Polyesters are also biocompatible and biodegradable polymers are used in the manufacture of various medical products, such as bone fixing products, sutures, stent, screws, pins, and tissue repairs, as their physicochemical properties are ideal for a wide variety of medical uses. Polyesters are also used commercially in managed vehicles for the drug delivery. Polyesters function as a biologically inert supporting material in all existing consumer goods as a mesh or a drug-releasing device. Polyesters are updated to tackle concerns such as low cell adhesion, hydrophobicity, and inflammatory side effects for more advanced medical and regenerative applications. Consequently, polyester alteration has become one of the main research topics in material engineering and polymer science.

The properties of polyesters and the modification methods applied to strengthen some of the disadvantages of this class of polymers are discussed in this study. In specific, this analysis includes applications and modifications of the most widely used polyesters such as polylactic acid (PLA), poly(ÿ-caprolactone) (PCL), poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV), poly(lactic-co - glycolic acid) (PLGA, poly-3-hydroxybutyrate (or poly-β-hydroxybutyric acid, PHB), poly(propylene carbonate) (PPPC), poly(propylene fumarate) (PPF) and poly(butylene succinate) (PBS) (PBS).

Polyesters are primarily manufactured using random polymerisation, ring opening polymerisation, and chain copolymerisation techniques. For example, PCL is provided by opening ring polymerization of π-caprolactone with a catalyst such as an octoate. The vast majority of polyesters come from petroleum

dependent carbohydrate sources. Therefore, there has been a movement in recent decades to find alternative, renewable polymers. Only PPC, PHB, and PLA come from renewable sources across all polyesters. In the presence of an active catalyst such as zinc glutarate, PPC is produced commercially from the ring opening reaction between CO2 and propylene oxide. Different mechanisms of ring opening polymerization used to synthesize PPC and PCL are also used to synthesize PLA. The PLA synthesis is a multi-step fermentation process that starts with the lactic acid biosynthesis. Lactic acid is first converted into its cyclic lactide foam and then polymerised through a metal catalyst.

Linear aliphatic polyesters are mainly biodegradable polymers with hydrophobicity. Our customizable physical and mechanical properties have expanded our biomedical applications. Processing these materials into desired structures is simple, with minimal toxicity, immunogenicity, and infection risks.